MOISTURE VAPOR BARRIER LAMINATE

Background of the Invention

[0001] The present invention is a paperboard laminate comprising a paperboard substrate, having an interior surface and an exterior surface, a layer of high density polyethylene on the interior surface of the paperboard substrate, a tie layer interior to the high density polyethylene layer, a barrier layer interior to the high density polyethylene layer, a second tie layer interior to the barrier layer, and a polyolefin layer interior to the second tie layer. The laminate is useful for packaging dry food products such as ready-to-eat cereals, powdered drink mixes and baking goods, and non-food products such as dry laundry detergent, fertilizer pellets, and powdered air fresheners.

[0002] Moisture is a primary factor limiting packaged dry food and non-food shelf life. Moisture changes are especially limiting for a shelf life longer than one year. Typically, products requiring shelf life longer than one year are packaged in glass jars, metal cans or paperboard foil laminate packages. However, in the case of paperboard foil laminates, the foil is susceptible to cracking, particularly in the score areas during conversion into a package, is expensive, and difficult to recycle in many regions of the world. The laminate of the present invention has water vapor barrier to prevent moisture gain/loss and subsequent texture changes and mold growth, and excellent oxygen barrier to minimize, for example, lipid oxidation and the formation of rancid off-odors/flavor.

[0003] The laminate of the present invention is useful for paper cartons for food products and other dry products. Conventional paper cartons for food products and other dry products are constructed of one or more layers of paper and include a plastic liner.

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The plastic liner is a bag used to seal the product and maintain product freshness. From a manufacturing and packaging point of view, the inner liner adds cost to the packaging operation, therefore it is desirable to produce a package or carton not requiring a plastic inner liner bag.

[0004] The present invention also provides a heat sealable laminate material having a low moisture vapor permeability during filling and storage over a range of temperatures and relative humidity.

Summary of the Invention

[0005] The present invention is a paperboard laminate comprising a paperboard substrate, having an interior surface and an exterior surface, a layer of high density polyethylene on the interior surface of the paperboard substrate, a tie layer interior to the high density polyethylene layer, a barrier layer interior to the high density polyethylene layer, a second tie layer interior to the barrier layer, and a polyolefin layer interior to the second tie layer.

Brief Description of the Figures

[0006] **Fig. 1** is a cross-sectional view of the laminate of the present invention.

Fig. 2 is a graphic representation of % weight gain of dry, ready-to-eat cereal vs. days after filling for packages that were stored at 90 °F and 75% relative humidity.

Fig. 3 is a graphic representation of % weight gain of powdered creamer vs. days after filling for packages that were stored at 90 °F and 75% relative humidity.

Fig. 4 is a graphic representation of % weight gain of dry, ready-to-eat cereal vs. days after filling for packages that were stored at 90 °F and 75% relative humidity.

Figure 1. Laminate **5**.

Layer Number	Structure
12	Polyolefin
10	Basestock
14	HDPE
16	Tie
18	EVOH
20	Tie
22	Polyolefin

Detailed Description of the Invention

[0007] The present invention is a paperboard laminate comprising a paperboard substrate, having an interior surface and an exterior surface, a layer of high density polyethylene on the interior surface of the paperboard substrate, a tie layer interior to the high density polyethylene layer, a barrier layer interior to the high density polyethylene layer, a second tie layer interior to the barrier layer, and a polyolefin layer interior to the second tie layer.

[0008] Figure 1 shows a cross-sectional view of laminate **5** containing a paperboard substrate **10** of 100 to 300 lbs. per 3000 square feet onto which there is preferably applied on one side a coating of polyethylene polymer layer **12** such as low density polyethylene at a coating weight of 5 to 20 lbs. and preferably about 10 to12 lbs. to provide the outer surface of the laminate. There may be applications in which layer **12** is not needed. The substrate **10** may be liquid packaging board, folding carton, cupstock, or even a bleached or unbleached Kraft liner board.

[0009] The interior of the substrate **10**, has applied a high density polyethylene (HDPE) layer **14** at a coating weight of 10 to 40 lbs. and preferably about 20 to 30 lbs. The high density polyethylene has a density within the range of 0.941 g/cm^3 to 0.96 g/cm^3. Medium density polyethylene may also be used in layer **14** at the same coating weights. The medium density polyethylene has a density within the range of 0.926 g/cm^3 to 0.94 g/cm^3. In an alternative embodiment of the invention, high density or medium density polyethylene may be blended with low density polyethylene, however standard low density polyethylene would not provide sufficient water vapor barrier. Furthermore to obtain a sufficient water vapor barrier using low density polyethylene would require a coat weight thickness that is impractical if not impossible to manufacture.

[0010] The inner surface of layer **14** there is applied a tie layer **16** with a coat weight of 1 to10 lbs., preferably about 1.5 to 5 lbs. Suitable adhesive tie layers are polyolefins, anhydride modified polyolefins, ethylene acrylic acid, ethylene methyl

acrylic acid, ethylene vinyl acetates. Preferably the tie layer is based on, but not limited to, ethylene based copolymers modified with maleic anhydride functional groups.

[0011] The barrier layer **18** is applied interior to the high density polyethylene layer. Preferable layer **18** is a ethylene vinyl alcohol copolymer (EVOH) oxygen barrier and applied to the underside of the tie layer **16** and has a coating weight of 1 to10 lbs. and preferably about 3 to5 lbs. The EVOH material may contain 26 to 48 mole % ethylene. Layer **18** can also be, but is not limited to, oxygen scavenging EVOH material, EVOH nanocomposites, or blends of EVOH with polyolefins such as low density polyethylene. The EVOH layer **18** serves as a barrier to oxygen ingress. Another advantage is that EVOH is also a barrier to odors/aromas entering the carton and helps to prevent aroma/flavor scalping from the product. For products that do not require as much oxygen barrier, the EVOH could be replaced with a barrier layer selected from the group consisting of polyamides, polyethylene terephthalates, polyesters, polyvinyl alcohols, polyolefins, cyclic olefin copolymers, polycarbonates, liquid crystalline polymers and blends thereof, or blends of any of the foregoing with at least one member selected from the group consisting of desiccants, molecular sieves, and cyclodextrins.

[0012] A second tie layer **20** is applied to the underside of the layer **18**. As with tie layer **16**, the coating weight is typically 1 to10 lbs. and preferably 1.5 to 5 lbs. Finally, a layer **22** of polyolefin is applied over the tie layer **20** and may form the product contact surface. The polyolefin coat weight can be 1 to 30 lbs. and preferably about 5 to 10 lbs. Acceptable polyolefins include, but are not limited to, low density polyethylene,

high density polyethylene, linear low density polyethylene, polypropylene, metallocene, and blends thereof.

[0013] Referring to laminate **5** in Fig. 1, the polyolefin layer **12** is extrusion coated onto the substrate **10**. The HDPE layer **14** is then deposited on the uncoated side of the substrate **10**. The tie layer **16**, EVOH layer **18**, and tie layer **20** are applied as a coextrusion over the HDPE layer **14**. The tie layer **20** is then overcoated with polyolefin layer **22** forming laminate **5**. The laminate could also be produced as a five layer coextrusion consisting of HDPE layer **14**, tie layer **16**, EVOH layer **18**, tie layer **20**, and polyolefin layer **22**. While these are two methods of forming laminate **5**, other methods can be employed to result in the same final structure.

[0014] A laminate structure was prepared suitable for use in the packaging of dry food and non-food products. All weights are expressed in pounds per 3000 square feet.

[0015] The following examples are provided to illustrate the present invention. The examples are not intended to limit the claims herein.

Example 1

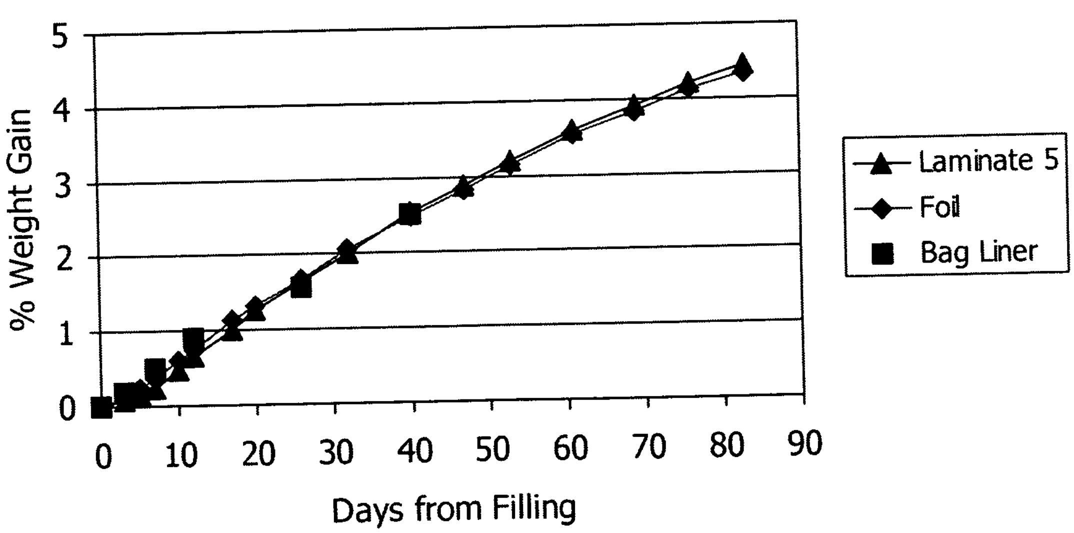
[0016] A moisture vapor barrier laminate consistent with the format of laminate **5** was produced using 30 lbs. HDPE in layer **14**, 4 lbs. EVOH in layer **18**, and 10 lbs. LDPE in layer **22**. The resulting flat sample was tested for water vapor transmission rate (WVTR) in comparison to standard cereal bag stock consisting of a 2 mil thick coextruded film of HDPE and ethylene vinyl acetate (EVA). Results for WVTR testing at 38 °C / 90% RH are shown below.

Sample	WVTR (grams/100 in^2/day)
Laminate	0.064
Bag stock	0.073

__Example 2__

[0017] The laminate defined in Example 1 was converted into skived, liter gable top cartons. Foil lined, nonskived, liter gable top cartons were also produced. Standard cereal bag stock in the form of a pouch was used for comparison. The cartons and pouches were filled with dry, ready-to-eat cereal and stored at accelerated test conditions of 90 °F and 75% relative humidity. One week at these storage conditions is believed to simulate one month of ambient storage. The packages were weighed periodically throughout the 6 week test. The percent weight gain of the cereal over time is plotted in Figure 2. Cereal in the three packages performed equivalently across the test period.

Figure 2. Cereal % weight gain at accelerated test conditions.



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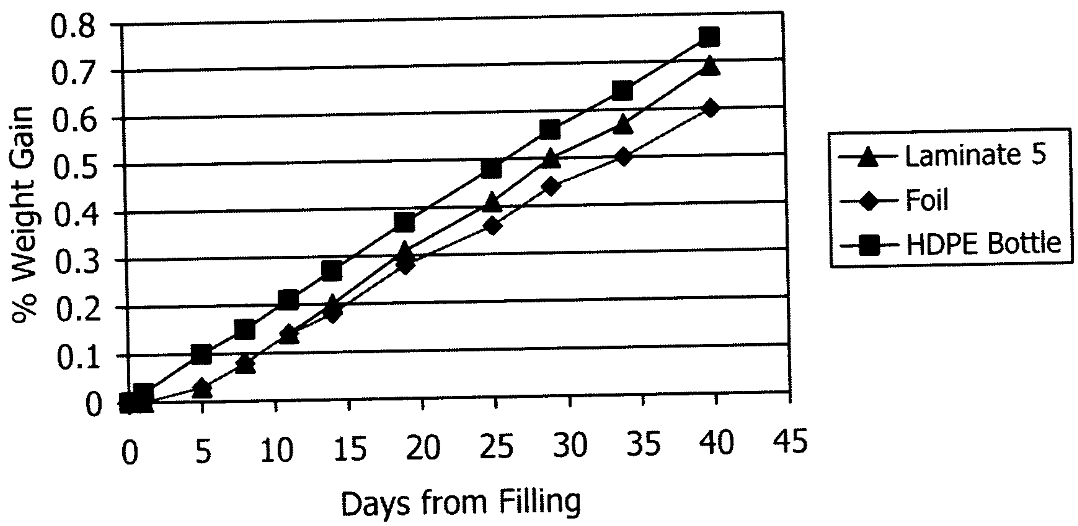
Example 3

[0018] The same cartons used in Example 2 were also filled with powdered coffee creamer and compared to a commercial HDPE bottle at accelerated test conditions. Percent weight gain of the creamer over time is shown in Figure 3.

Figure 3. Powdered creamer % weight gain at accelerated test conditions.



The food moisture in the three packages at day 40, measured by recording the difference in weight before and after drying at 105 °C for 15 minutes, was 4.3 weight % for the laminate **5** and foil cartons and 4.5 weight % for the HDPE bottle.

Example 4

[0019] A second laminate ("LDPE Version") similar in format to laminate **5** used in the above Examples was produced using 30 lbs. LDPE in layer **14**, 4 lbs. EVOH in layer **18**, and 10 lbs. LDPE in layer **22** and converted into skived liter gable top cartons. The cartons were filled with a dry, ready-to-eat cereal and stored at the same accelerated

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test conditions used in Examples 2 and 3. Percent weight gain of the cereal over time is plotted in Figure 4. After 42 days, percent moisture weight gain was 24% less in laminate **5** than in the LDPE Version laminate.

Figure 4. Cereal % weight gain at accelerated test conditions.